DETERMINATION OF STREAMFLOW DISCHARGE HYDROGRAPH IN THE ROMPIN RIVER BASIN

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Malaysia terjejas oleh dua masalah utama yang berkaitan dengan air iaitu banjir dan kemarau. Terdapat dua jenis banjir yang berlaku di negara ini iaitu banjir monsoon dan banjir kilat. Banjir monsun biasanya berlaku pada akhir tahun semasa monsun timur laut. Sebaliknya, kemarau berlaku semasa musim kering dari Mei hingga September. Oleh kerana air terlalu banyak atau terlalu kurang selalu menjadi masalah di Malaysia, ia penting untuk memahami proses hidrologi yang terlibat dalam lembangan sungai. Kajian ini bertujuan untuk menganggarkan pelepasan aliran sungai yang terdapat di sistem sungai semasa tempoh aliran tinggi dan rendah untuk Sungai Rompin. Model hidrologi yang digunakan untuk kajian ini adalah HEC-HMS. Model ini dipilih kerana ia mudah untuk digunakan dan tidak memerlukan pelesenan. Data 6 stesen hujan dan 2 stesen aliran sungai di Sungai Rompin Basin dari tahun 1990 hingga 2013 akan digunakan sebagai data input, proses penentukuran dan pengesahan. Untuk kaedah transformasi larian permukaan, kaedah SCS dipilih untuk mengubah taburan hujan ke hidrograf pelepasan. Dalam kajian ini, hipotesis bahawa model HEC-HMS dapat mensimulasikan aliran sungai di Sungai Rompin dengan kecekapan yang mencukupi untuk tempoh kering dan basah. Temuan ini penting sebagai alat sokongan keputusan yang boleh digunakan dalam operasi dan pengurusan kawasan Rompin, untuk bekalan air dan kawalan banjir.

ABSTRACT

Generally, the Rompin River Basin is affected by two major water-related problems, floods and droughts. There are two types of floods occur in this country which are the monsoon flood and flash flood. Monsoon floods normally took place at the end of the year during the north-east monsoon. Oppositely, drought occurs during the dry period from May to September causing insufficient water supply especially for irrigation purpose. Thus, it is important to understand the hydrological process involved in the river basins. This study aims to estimate the streamfow for the Rompin River Basin using HEC-HMS hydrological model, and calibrate and validate the transformed rainfall-runoff model. HEC-HMS model is chosen because it is simple to apply and require no licensing. Data of 6 rainfall and 2 streamflow stations in the Rompin River Basin from the year 1990 to 2013 were used in the input, calibration and validation processes. For the surface runoff transformation method, SCS method was selected. In this study, results indicate that the HEC-HMS model is able to simulate the streamflow in the Rompin River Basin with sufficient efficiency for both the dry and wet periods. This finding is important as a decision support tool that can be used in the operation and management of Rompin area, for both water supply and flood control.

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LIST OF SYMBOLS

t_c	Time of concentration, min
L	Travel length, m
S	Slope
t_L	Lag time, min
Obs	Observed discharge, m/s^3
Sim	Simulated discharge, m/s^3
Omean	Mean observed discharge, m/s^3

LIST OF ABBREVIATIONS

RRB	Rompin River Basin
DID	Department of Irrigation and Drainage
JUPEM	Department of Survey and Mapping Malaysia
HEC-HMS	Hydrologic Modeling System
CN	Curve Number
RMSE	Root Mean Square Error
NSE	Nash-Sutcliffe Efficiency

CHAPTER 1

INTRODUCTION

1.1 Background

Malaysia is rich in water resources, receiving an abundant amount of rain every year. Malaysia's climate is categorised as equatorial and is hot and humid throughout the year. The average rainfall is 2500mm a year with average temperature of 27 °C (De Silva, Samat, Zakaria, and Agbayani, 1992). Malaysia has only two seasons – wet and dry. The wet season lasts from October to March, with November being the wettest month with a total rainfall of around 305mm. The dry season occurs from May to September, with the driest month being June – with a rainfall of around 102mm.

During the wet, Malaysia is prone to flood problem. Flood in this country can be categorised into two, monsoon flood and flash flood (Diya, Gasim, Toriman, & Abdullahi, 2014). Monsoon flood generally occurs between November to February on the monsoon season and hit badly on the east coast of Peninsular Malaysia. Flash flood is a sudden local flood that typically due to heavy rain in short duration and often occurs at the urban areas. Flood is one of the natural disasters that bring impact to the Malaysian community and economy system.

Rompin River Basin (RRB) which is located at the southeastern corner of the Pahang state in Malaysia is one of the region that is affected by the monsoon flood. It receives heavy rainfall during the north east monsoon which leads to severe flooding in the areas almost every year. The December 2013 flood event was the worst ever recorded in decades with 3615 victims (Zaidi, Akbari and Ishak, 2014). This has caused millions of ringgits property damage with thousands of people affected and loss of life.

Agriculture is one of the important sector of Malaysia's economy, accounting for 12% of the national GDP and providing employment opportunities for 16% of the population (British, Asia, Malaysian, and Council, 2015). Food and agriculture are the biggest consumers of water and require one hundred times more than the domestic demand (Lenntech, 2011). As the population continues to increase, more food and livestock feed will be needed to be produced in the future and more water will be used for this purpose. The amount of water involved in agriculture is significant and most of it is provided directly by rainfall. In Malaysia, Rompin is one of the state in which the economy mostly depending on agriculture activities. Agriculture lands in the Rompin River Basin cover near to 50% of the landuse including several paddy schemes which require large amount of water usage. Therefore, there is a need to study the streamflow discharge in Rompin area for effective water management to cater for future development especially in the dry season.

There are numbers of software developed to analyse the rainfall-runoff processes. One of the commonly used is the Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS). This modelling program is able to simulate the rainfall-runoff processes of dendritic watershed system (Razi, Ariffin, Tahir, and Arish, 2010). Furthermore, the software is an open source application that can be downloaded from the U.S. Army Corporation website without charges. Therefore, it is a very popular modelling tool worldwide including in Malaysia (Halwatura and Najim, 2013). Another advantages of this software are its ability to stimulate short-term events, easy to use and it applies the common hydrologic basic.

In HEC-HMS model, several methods can be applied to simulate the surface runoff of the model and different methods may produce different results. For example, the rainfall runoff losses in the HEC-HMS model can be estimated by using Conservation Service (SCS), Green and Ampt, Initial Constant, Deficit Constant, Constant Fraction, exponential and Soil Moisture Accounting (SMA) (Razmkhah, 2016). The outcome generated by using the HEC-HMS model is the hydrograph for the basin and river system. From the hydrograph, the flood and dry peak can be identified (Feldman, 2000). This finding is important as a decision support tool that can be used in the operation and management of the RRB, for both water supply and flood control.

1.2 Problem Statement

Flood is one of the regular natural disasters and has become a common phenomenon in Malaysia especially on the east coast including RRB (Basarudin, Adnan, Wardah, and Syafiqah, 2014). Basically, river flooding occurs because of the heavy rainfall which resultant in large concentration of runoff that exceeded the capacity of the river. The peak discharge and volume of runoff increase with increasing rainfall intensity for a given infiltration rate. Apart from flood problem, RRB also receive low rainfall during the dry period. This sometimes affect the agriculture needs especially for the paddy plantations. Hence, it is crucial to develop a rainfall-runoff model for RRB using HEC-HMS to analyse the hydrological processes and determine the rainfall-runoff processes in the basin.

1.3 Objectives

The purpose of this study is to stimulate streamflow estimation for water management applying HEC-HMS model with SCS unit hydrograph method in the Rompin River Basin. The objectives of the study are:

1. To determine streamflow discharge
2. To calibrate and validate transformation model

1.4 Scope of Study

Rompin River Basin is selected as the study area in this research mainly for the flood control, agriculture and domestic water supply. Streamflow hydrographs were simulated for several events on the wet and dry periods using HEC-HMS model with SCS unit hydrograph transformation method. For the calibration process, the basin characteristics parameters were calibrated using the streamflow data collected from the streamflow station for year 1990 to 2013. The simulated results were then validated using another set of data to ensure the reliability of the calibrated parameters.

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